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Ada Compiler Validation Summary Report:

Compiler Name: DACS-386/UNIX, Version 4.2

Certificate Number: 880728S1.09140

|                                |                                |
|--------------------------------|--------------------------------|
| Host:                          | Target:                        |
| RC900 (386/UNIX V Workstation) | RC900 (386/UNIX V Workstation) |
| under UNIX V Rel. 1.0.4        | under UNIX V Rel. 1.0.4        |

Testing Completed 28 July 1988 Using ACVC 1.9

This report has been reviewed and is approved.



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AVF Control Number: NBS88VDDC545\_1

Ada Compiler  
VALIDATION SUMMARY REPORT:  
Certificate Number: 880728S1.09140  
DDC-I, Inc.  
DACS-386/UNIX, Version 4.2  
RC900 (386/UNIX V Workstation)

Completion of On-Site Testing:  
28 July 1988

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## CHAPTER 1

### INTRODUCTION

This Validation Summary Report (VSR) describes the extent to which a specific Ada compiler conforms to the Ada Standard, ANSI/MIL-STD-1815A. This report explains all technical terms used within it and thoroughly reports the results of testing this compiler using the Ada Compiler Validation Capability (ACVC). An Ada compiler must be implemented according to the Ada Standard, and any implementation-dependent features must conform to the requirements of the Ada Standard. The Ada Standard must be implemented in its entirety, and nothing can be implemented that is not in the Standard.

Even though all validated Ada compilers conform to the Ada Standard, it must be understood that some differences do exist between implementations. The Ada Standard permits some implementation dependencies--for example, the maximum length of identifiers or the maximum values of integer types. Other differences between compilers result from the characteristics of particular operating systems, hardware, or implementation strategies. All the dependencies observed during the process of testing this compiler are given in this report.

This information in this report is derived from the test results produced during validation testing. The validation process includes submitting a suite of standardized tests, the ACVC, as inputs to an Ada compiler and evaluating the results. The purpose of validating is to ensure conformity of the compiler to the Ada Standard by testing that the compiler properly implements legal language constructs and that it identifies and rejects illegal language constructs. The testing also identifies behavior that is implementation dependent but permitted by the Ada Standard. Six classes of test are used. These tests are designed to perform checks at compile time, at link time, and during execution.

## 1.1 PURPOSE OF THIS VALIDATION SUMMARY REPORT

This VSR documents the results of the validation testing performed on an Ada compiler. Testing was carried out for the following purposes:

To attempt to identify any language constructs supported by the compiler that do not conform to the Ada Standard

To attempt to identify any unsupported language constructs required by the Ada Standard

To determine that the implementation-dependent behavior is allowed by the Ada Standard

On-site testing was completed 28 July 1988 at Copenhagen, Denmark.

## 1.2 USE OF THIS VALIDATION SUMMARY REPORT

Consistent with the national laws of the originating country, the AVO may make full and free public disclosure of this report. In the United States, this is provided in accordance with the "Freedom of Information Act" (5 U.S.C. #552). The results of this validation apply only to the computers, operating systems, and compiler versions identified in this report.

The organizations represented on the signature page of this report do not represent or warrant that all statements set forth in this report are accurate and complete, or that the subject compiler has no nonconformities to the Ada Standard other than those presented. Copies of this report are available to the public from:

Ada Information Clearinghouse  
Ada Joint Program Office  
OUSDRE  
The Pentagon, Rm 3D-139 (Fern Street)  
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Questions regarding this report or the validation test results should be directed to the AVF listed above or to:

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### 1.3 REFERENCES

1. Reference Manual for the Ada Programming Language, ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.
2. Ada Compiler Validation Procedures and Guidelines. Ada Joint Program Office, 1 January 1987.
3. Ada Compiler Validation Capability Implementers' Guide., December 1986.

### 1.4 DEFINITION OF TERMS

|                |   |
|----------------|---|
| ACVC           | The Ada Compiler Validation Capability. The set of Ada programs that tests the conformity of an Ada compiler to the Ada programming language.   |
| Ada Commentary | An Ada Commentary contains all information relevant to the point addressed by a comment on the Ada Standard. These comments are given a unique identification number having the form AI-ddddd.  |
| Ada Standard   | ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.  |
| Applicant      | The agency requesting validation.   |
| AVF            | The Ada Validation Facility. The AVF is responsible for conducting compiler validations according to procedures contained in the <u>Ada Compiler Validation Procedures and Guidelines</u> .   |
| AVO            | The Ada Validation Organization. The AVO has oversight authority over all AVF practices for the purpose of maintaining a uniform process for validation of Ada compilers. The AVO provides administrative and technical support for Ada validations to ensure consistent practices. |
| Compiler       | A processor for the Ada language. In the context of this report, a compiler is any language processor, including cross-compilers, translators, and  |

interpreters.

|                      |   |
|----------------------|---|
| Failed test          | An ACVC test for which the compiler generates a result that demonstrates nonconformity to the Ada Standard.   |
| Host                 | The computer on which the compiler resides.   |
| Inapplicable test    | An ACVC test that uses features of the language that a compiler is not required to support or may legitimately support in a way other than the one expected by the test.  |
| Language Maintenance | The Language Maintenance Panel (LMP) is a committee established by the Ada Board to recommend interpretations and Panel possible changes to the ANSI/MIL-STD for Ada.   |
| Passed test          | An ACVC test for which a compiler generates the expected result.  |
| Target               | The computer for which a compiler generates code.   |
| Test                 | An Ada program that checks a compiler's conformity regarding a particular feature or a combination of features to the Ada Standard. In the context of this report, the term is used to designate a single test, which may comprise one or more files. |
| Withdrawn test       | An ACVC test found to be incorrect and not used to check conformity to the Ada Standard. A test may be incorrect because it has an invalid test objective, fails to meet its test objective, or contains illegal or erroneous use of the language.    |

### 1.5 ACVC TEST CLASSES

Conformity to the Ada Standard is measured using the ACVC. The ACVC contains both legal and illegal Ada programs structured into six test classes: A, B, C, D, E, and L. The first letter of a test name identifies the class to which it belongs. Class A, C, D, and E tests are executable, and special program units are used to report their results during execution. Class B tests are expected to produce compilation errors. Class L tests are expected to produce compilation or link errors.

Class A tests check that legal Ada programs can be successfully compiled and executed. There are no explicit program components in a Class A test to check semantics. For example, a Class A test checks that reserved words of another language (other than those already reserved in the Ada language) are not treated as reserved words by an Ada compiler.



A Class A test is passed if no errors are detected at compile time and the program executes to produce a PASSED message.

Class B tests check that a compiler detects illegal language usage. Class B tests are not executable. Each test in this class is compiled and the resulting compilation listing is examined to verify that every syntax or semantic error in the test is detected. A Class B test is passed if every illegal construct that it contains is detected by the compiler.

Class C tests check that legal Ada programs can be correctly compiled and executed. Each Class C test is self-checking and produces a PASSED, FAILED, or NOT APPLICABLE message indicating the result when it is executed.

Class D tests check the compilation and execution capacities of a compiler. Since there are no capacity requirements placed on a compiler by the Ada Standard for some parameters--for example, the number of identifiers permitted in a compilation or the number of units in a library--a compiler may refuse to compile a Class D test and still be a conforming compiler. Therefore, if a Class D test fails to compile because the capacity of the compiler is exceeded, the test is classified as inapplicable. If a Class D test compiles successfully, it is self-checking and produces a PASSED or FAILED message during execution.

Each Class E test is self-checking and produces a NOT APPLICABLE, PASSED, or FAILED message when it is compiled and executed. However, the Ada Standard permits an implementation to reject programs containing some features addressed by Class E tests during compilation. Therefore, a Class E test is passed by a compiler if it is compiled successfully and executes to produce a PASSED message, or if it is rejected by the compiler for an allowable reason.

Class L tests check that incomplete or illegal Ada programs involving multiple, separately compiled units are detected and not allowed to execute. Class L tests are compiled separately and execution is attempted. A Class L test passes if it is rejected at link time--that is, an attempt to execute the main program must generate an error message before any declarations in the main program or any units referenced by the main program are elaborated.

Two library units, the package REPORT and the procedure CHECK\_FILE, support the self-checking features of the executable tests. The package REPORT provides the mechanism by which executable tests report PASSED, FAILED, or NOT APPLICABLE results. It also provides a set of identity functions used to defeat some compiler optimizations allowed by the Ada Standard that would circumvent a test objective. The procedure CHECK\_FILE is used to check the contents of text files written by some of the Class C tests for chapter 14 of the Ada Standard. The operation of REPORT and CHECK\_FILE is checked by a set of executable tests. These tests produce messages that are examined to verify that the units are operating correctly. If these units are not operating correctly, then

the validation is not attempted.

The text of the tests in the ACVC follow conventions that are intended to ensure that the tests are reasonably portable without modification. For example, the tests make use of only the basic set of 55 characters, contain lines with a maximum length of 72 characters, use small numeric values, and place features that may not be supported by all implementations in separate tests. However, some tests contain values that require the test to be customized according to implementation-specific values--for example, an illegal file name. A list of the values used for this validation is provided in Appendix C.

A compiler must correctly process each of the tests in the suite and demonstrate conformity to the Ada Standard by either meeting the pass criteria given for the test or by showing that the test is inapplicable to the implementation. The applicability of a test to an implementation is considered each time the implementation is validated. A test that is inapplicable for one validation is not necessarily inapplicable for a subsequent validation. Any test that was determined to contain an illegal language construct or an erroneous language construct is withdrawn from the ACVC and, therefore, is not used in testing a compiler. The tests withdrawn at the time of validation are given in Appendix D.

CHAPTER 2  
CONFIGURATION INFORMATION

2.1 CONFIGURATION TESTED

The candidate compilation system for this validation was tested under the following configuration:

Compiler: DACS-386/UNIX, Version 4.2

ACVC Version: 1.9

Certificate Number: 880728S1.09140

Host Computer:

Machine: RC900 (386/UNIX V Workstation)

Operating System: UNIX V Rel. 1.0.4

Memory Size: 16 Mbyte RAM

Target Computer:

Machine: RC900 (386/UNIX V Workstation)

Operating System: UNIX V Rel. 1.0.4

Memory Size: 16 Mbyte RAM

Communications Network: VAX-11/8530 via Ethernet LAN via  
SUN-3 Workstation via streamer tape  
to the RC900 (386/UNIX V  
Workstation).

## 2.2 IMPLEMENTATION CHARACTERISTICS

One of the purposes of validating compilers is to determine the behavior of a compiler in those areas of the Ada Standard that permit implementations to differ. Class D and E tests specifically check for such implementation differences. However, tests in other classes also characterize an implementation. The tests demonstrate the following characteristics:

- Capacities.

The compiler correctly processes tests containing loop statements nested to 65 levels and recursive procedures separately compiled as subunits nested to 17 levels. It does not process 65 levels of block nesting. It correctly processes a compilation containing 723 variables in the same declarative part. (See test D55A03A..H (8 tests), D56001B, D64005E..G (3 tests), and D29002K.)

- Universal integer calculations.

An implementation is allowed to reject universal integer calculations having values that exceed `SYSTEM.MAX_INT`. This implementation processes 64 bit integer calculations. (See tests D4A002A, D4A002B, D4A004A, and D4A004B.)

- Predefined types.

This implementation supports the additional predefined types `SHORT_INTEGER`, `LONG_INTEGER`, and `LONG_FLOAT` in the package `STANDARD`. (See tests B86001BC and B86001D.)

- Based literals.

An implementation is allowed to reject a based literal with a value exceeding `SYSTEM.MAX_INT` during compilation, or it may raise `NUMERIC_ERROR` or `CONSTRAINT_ERROR` during execution. This implementation raises `NUMERIC_ERROR` during execution. (See test E24101A.)

- Expression evaluation.

Apparently all default initialization expressions for record components are evaluated before any value is checked to belong to a component's subtype. (See test C32117A.)

Assignments for subtypes are performed with the same precision as the base type. (See test C35712B.)

This implementation uses no extra bits for extra precision. This implementation uses all extra bits for extra range. (See test C35903A.)

Apparently `NUMERIC_ERROR` is raised when an integer literal operand in a comparison or membership test is outside the range of the base type. (See test C45232A.)

Apparently `NUMERIC_ERROR` is raised when a literal operand in a fixed point comparison or membership test is outside the range of the base type. (See test C45252A.)

Apparently underflow is gradual. (See tests C45524A..Z.)

#### - Rounding.

The method used for rounding to integer is apparently round to even. (See tests C46012A..Z.)

The method used for rounding to longest integer is apparently round to even. (See tests C46012A..Z.)

The method used for rounding to integer in static universal real expressions is apparently round away from zero. (See test C4A014A.)

#### - Array types.

An implementation is allowed to raise `NUMERIC_ERROR` or `CONSTRAINT_ERROR` for an array having a `'LENGTH` that exceeds `STANDARD.INTEGER'LAST` and/or `SYSTEM.MAX_INT`. For this implementation:

Declaration of an array type or subtype declaration with more than `SYSTEM.MAX_INT` components raises `NUMERIC_ERROR`. (See test C36003A.)

`NUMERIC_ERROR` is raised when an array type with `INTEGER'LAST + 2` components is declared. (See test C36202A.)

`NUMERIC_ERROR` is raised when an array type with `SYSTEM.MAX_INT + 2` components is declared. (See test C36202B.)

A packed `BOOLEAN` array having a `'LENGTH` exceeding `INTEGER'LAST`

raises `NUMERIC_ERROR` when the array objects are declared. (See test C52103X.)

A packed two-dimensional `BOOLEAN` array with more than `INTEGER'LAST` components raises `NUMERIC_ERROR` when the array type is declared. (See test C52104Y.)

A null array with one dimension of length greater than `INTEGER'LAST` may raise `NUMERIC_ERROR` or `CONSTRAINT_ERROR` either when declared or assigned. Alternatively, an implementation may accept the declaration. However, lengths must match in array slice assignments. This implementation raises `NUMERIC_ERROR` when the array type is declared. (See test E52103Y.)

In assigning one-dimensional array types, the expression appears to be evaluated in its entirety before `CONSTRAINT_ERROR` is raised when checking whether the expression's subtype is compatible with the target's subtype. In assigning two-dimensional array types, the expression appears to be evaluated in its entirety before `CONSTRAINT_ERROR` is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

#### - Discriminated types.

During compilation, an implementation is allowed to either accept or reject an incomplete type with discriminants that is used in an access type definition with a compatible discriminant constraint. This implementation accepts such subtype indications. (See test E38104A.)

In assigning record types with discriminants, the expression appears to be evaluated in its entirety before `CONSTRAINT_ERROR` is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

#### - Aggregates.

In the evaluation of a multi-dimensional aggregate, all choices appear to be evaluated before checking against the index subtype. (See tests C43207A and C43207B.)

In the evaluation of an aggregate containing subaggregates, not all choices are evaluated before being checked for identical bounds. (See test E43212B.)

All choices are evaluated before `CONSTRAINT_ERROR` is raised if a bound in a nonnull range of a nonnull aggregate does not belong to an index subtype. (See test E43211B.)

- Representation clauses.

An implementation might legitimately place restrictions on representation clauses used by some of the tests. If a representation clause is not supported, then the implementation must reject it.

Enumeration representation clauses containing noncontiguous values for enumeration types other than character and boolean types are supported. (See tests C35502I..J, C35502M..N, and A39005F.)

Enumeration representation clauses containing noncontiguous values for character types are supported. (See tests C35507I..J, C35507M..N, and C55B16A.)

Enumeration representation clauses for boolean types containing representational values other than (FALSE => 0, TRUE => 1) are not supported. (See tests C35508I..J and C35508M..N.)

Length clauses with SIZE specifications for enumeration types are supported. (See test A39005B.)

Length clauses with STORAGE\_SIZE specifications for access types are supported. (See test A39005C.)

Length clauses with STORAGE\_SIZE specifications for task types are supported. (See tests A39005D and C87B62D.)

Length clauses with SMALL specifications are not supported. (See tests A39005E and C87B62C.)

Record representation clauses are not supported. (See test A39005G.)

Length clauses with SIZE specifications for derived integer types are supported. (See test C87B62A.)

- Pragmas.

The pragma `INLINE` is supported for procedures. The pragma `INLINE` is supported for functions. (See tests LA3004A, LA3004B, EA3004C, EA3004D, CA3004E, and CA3004F.)

- Input/output.

The package `SEQUENTIAL_IO` can be instantiated with unconstrained array types and record types with discriminants without defaults. (See tests AE2101C, EE2201D, and EE2201E.)

The package `DIRECT_IO` can be instantiated with record types with discriminants without defaults. (See tests `AE2101H` and `EE2401G`.)

There are no strings which are illegal external file names for `SEQUENTIAL_IO` and `DIRECT_IO`. (See tests `CE2102C` and `CE2102H`.)

Modes `IN_FILE` and `OUT_FILE` are supported for `SEQUENTIAL_IO`. (See tests `CE2102D` and `CE2102E`.)

Modes `IN_FILE`, `OUT_FILE`, and `INOUT_FILE` are supported for `DIRECT_IO`. (See tests `CE2102F`, `CE2102I`, and `CE2102J`.)

`RESET` and `DELETE` are supported for `SEQUENTIAL_IO` and `DIRECT_IO`. (See tests `CE2102G` and `CE2102K`.)

Dynamic creation and deletion of files are supported for `SEQUENTIAL_IO` and `DIRECT_IO`. (See tests `CE2106A` and `CE2106B`.)

Overwriting to a sequential file truncates the file to last element written. (See test `CE2208B`.)

An existing text file can be opened in `OUT_FILE` mode, cannot be created in `OUT_FILE` mode, and cannot be created in `IN_FILE` mode. (See test `EE3102C`.)

Only one internal file may be associated with the same external file if only one file is opened for writing. (See test `CE3111B`.)

More than one internal file can be associated with each external file for text I/O for reading only or for writing only. (See tests `CE3111A`, `CE3111C..E` (3 tests), `CE3114B`, `CE3115A`, `CE2110B`, and `CE2111D`.)

More than one internal file can be associated with each external file for sequential I/O for both reading and writing. (See tests `CE2107A..D` (4 tests), `CE2110B`, and `CE2111D`.)

More than one internal file can be associated with each external file for direct and sequential I/O for writing only. (See test `CE2107E`.)

More than one internal file can be associated with each external file for direct I/O for both reading and writing. (See tests `CE2107F..I` (4 tests), and `CE2110B`.)

More than one internal file cannot be associated with each external file for direct I/O for both reading and writing. (See test `CE2111H`.)



An external file associated with more than one internal file can be deleted for SEQUENTIAL\_IO, DIRECT\_IO, and TEXT\_IO. (See test CE2110B.)

Temporary sequential files are given names. Temporary direct files are given names. Temporary files given names are not deleted when they are closed. (See tests CE2108A and CE2108C.)

- Generics.

Generic subprogram declarations and bodies can be compiled in separate compilations. (See test CA1012A.)

Generic package declarations and bodies can be compiled in separate compilations so long as no instantiations of those units precede the bodies. This compiler requires that a generic unit's body be compiled prior to instantiation, and so the unit containing the instantiations is rejected. (See tests CA2009C, BC3204C, and BC3205D.)

Generic unit bodies and their subunits can be compiled in separate compilations. (See test CA3011A.)

CHAPTER 3  
TEST INFORMATION

3.1 TEST RESULTS

Version 1.9 of the ACVC comprises 3122 tests. When this compiler was tested, 28 tests had been withdrawn because of test errors. The AVF determined that 236 tests were inapplicable to this implementation. All inapplicable tests were processed during validation testing. Modifications to the code, processing, or grading for 69 tests were required to successfully demonstrate the test objective. (See section 3.6.)

The AVF concludes that the testing results demonstrate acceptable conformity to the Ada Standard.

3.2 SUMMARY OF TEST RESULTS BY CLASS

| RESULT       | TEST CLASS |      |      |    |    |    | TOTAL |
|--------------|------------|------|------|----|----|----|-------|
|              | A          | B    | C    | D  | E  | L  |       |
| Passed       | 108        | 1048 | 1624 | 16 | 16 | 46 | 2858  |
| Inapplicable | 2          | 3    | 229  | 1  | 1  | 0  | 236   |
| Withdrawn    | 3          | 2    | 21   | 0  | 2  | 0  | 28    |
| TOTAL        | 113        | 1053 | 1874 | 17 | 19 | 46 | 3122  |

### 3.3 SUMMARY OF TEST RESULTS BY CHAPTER

| RESULT       | CHAPTER |     |     |     |     |    |     |     |     |    |     |    |     |  | TOTAL |
|--------------|---------|-----|-----|-----|-----|----|-----|-----|-----|----|-----|----|-----|--|-------|
|              | 2       | 3   | 4   | 5   | 6   | 7  | 8   | 9   | 10  | 11 | 12  | 13 | 14  |  |       |
| Passed       | 187     | 494 | 548 | 247 | 165 | 98 | 140 | 326 | 135 | 36 | 232 | 3  | 247 |  | 2858  |
| Inapplicable | 17      | 78  | 126 | 1   | 0   | 0  | 3   | 1   | 2   | 0  | 2   | 0  | 6   |  | 236   |
| Withdrawn    | 2       | 14  | 3   | 0   | 1   | 1  | 2   | 0   | 0   | 0  | 2   | 1  | 2   |  | 28    |
| TOTAL        | 206     | 586 | 677 | 248 | 166 | 99 | 145 | 327 | 137 | 36 | 236 | 4  | 255 |  | 3122  |

### 3.4 WITHDRAWN TESTS

The following 28 tests were withdrawn from ACVC Version 1.9 at the time of this validation:

|         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|
| B28003A | E28005C | C34004A | C35502P | A35902C | C35904A |
| C35904B | C35A03E | C35A03R | C37213H | C37213J | C37215C |
| C37215E | C37215G | C37215H | C38102C | C41402A | C45332A |
| C45614C | E66001D | A74106C | C85018B | C87B04B | CC1311B |
| BC3105A | AD1A01A | CE2401H | CE3208A |         |         |

See Appendix D for the reason that each of these tests was withdrawn.

### 3.5 INAPPLICABLE TESTS

Some tests do not apply to all compilers because they make use of features that a compiler is not required by the Ada Standard to support. Others may depend on the result of another test that is either inapplicable or withdrawn. The applicability of a test to an implementation is considered each time a validation is attempted. A test that is inapplicable for one validation attempt is not necessarily inapplicable for a subsequent attempt. For this validation attempt, 236 test were inapplicable for the reasons indicated:

C24113I..K (3 tests) were rejected because they contain declarations that exceed MAX\_IN\_LEN (126 characters)

C35508I..J (2 tests) and C35508M..N (2 tests) use enumeration representation clauses for boolean types containing representational values other than (FALSE -> 0, TRUE -> 1). These clauses are not supported by this compiler.

C35702A uses SHORT\_FLOAT which is not supported by this implementation.

A39005E and C87B62C use length clauses with SMALL specifications which are not supported by this implementation.

A39005G uses a record representation clause which is not supported by this compiler.

C45231D requires a macro substitution for any predefined numeric types other than INTEGER, SHORT\_INTEGER, LONG\_INTEGER, FLOAT, SHORT\_FLOAT, and LONG\_FLOAT. This implementation supports only INTEGER, LONG\_INTEGER, FLOAT, and LONG\_FLOAT.

C45531M, C45531N, C45532M, and C45532N use fine 48 bit fixed point base types which are not supported by this compiler.

C45531O, C45531P, C45532O, and C45532P use coarse 48 bit fixed point base types which are not supported by this compiler.

C4A013B uses a static value that is outside the range of the most accurate floating point base type. The declaration was rejected at compile time.

D56001B uses 65 levels of block nesting which exceeds the capacity of the compiler.

B86001D requires a predefined numeric type other than those defined by the Ada language in package STANDARD. There is no such type for this implementation.

C87B62B this test contains the application of the attribute STORAGE\_SIZE to access types for which no corresponding STORAGE\_SIZE length clause has been provided; this compiler rejects such an application. The AVO accepted this behavior because the Ada standard is not clear on how such a situation should be treated; the matter will be discussed by the language maintenance body.

C96005B requires the range of type DURATION to be different from those of its base type; in this implementation they are the same.

CA2009C, BC3204C, BC3205D, and CA2009F compiles generic subprogram declarations and bodies in separate compilations; the compilation occurs following a compilation that contains instantiations of those units. This compiler requires that a generic unit's body be compiled prior to instantiation, and so the unit containing the instantiations is rejected.

CE2105A checks that CREATE is permitted for an IN\_FILE for SEQUENTIAL\_IO. An implementation can raise USE\_ERROR or NAME\_ERROR (see AI-00332). This implementation raises USE\_ERROR.

CE2105B checks that CREATE is permitted for an IN\_FILE for DIRECT\_IO. An implementation can raise USE\_ERROR or NAME\_ERROR (see AI-00332). This implementation raises USE\_ERROR.

CE2111H checks whether resetting an internal file has any effect upon other internal files accessing the same external file for DIRECT\_IO. An implementation can raise USE\_ERROR or NAME\_ERROR (see AI-00332). This implementation raises USE\_ERROR.

CE3109A checks that CREATE is permitted for an IN\_FILE. An implementation can raise USE\_ERROR or NAME\_ERROR (see AI-00332). This implementation raises USE\_ERROR.

CE3111B checks whether more than one internal file may be associated with the same external file if only one file is opened for writing. An implementation can raise USE\_ERROR or NAME\_ERROR (see AI-00332). This implementation allows an external file to be simultaneously opened for reading and writing. However, the exception END\_ERROR is raised. The reason for END\_ERROR being raised is that this implementation allows more than one internal file to be associated with the same external file while one is OPENed in IN\_FILE mode and the other is OPENed in OUT\_FILE mode with the output being directed to a buffer. When the file is read, the END\_ERROR exception is raised because the output has not been flushed to the external file; if the buffer were small enough or the output large enough then the output would be flushed to the external file, but this is problematic. Ada does not define the physical status of a file until that file has been closed.

EE2401D uses instantiations of package DIRECT\_IO with unconstrained array types. These instantiations are rejected by this compiler.

The following 201 tests require a floating-point accuracy that exceeds the maximum of 15 digits supported by this implementation:

|                       |                       |
|-----------------------|-----------------------|
| C24113L..Y (14 tests) | C35705L..Y (14 tests) |
| C35706L..Y (14 tests) | C35707L..Y (14 tests) |
| C35708L..Y (14 tests) | C35802L..Z (15 tests) |
| C45241L..Y (14 tests) | C45321L..Y (14 tests) |
| C45421L..Y (14 tests) | C45521L..Z (15 tests) |
| C45524L..Z (15 tests) | C45621L..Z (15 tests) |
| C45641L..Y (14 tests) | C46012L..Z (15 tests) |

### 3.6 TEST, PROCESSING, AND EVALUATION MODIFICATIONS

It is expected that some tests will require modifications of code, processing, or evaluation in order to compensate for legitimate implementation behavior. Modifications are made by the AVF in cases where legitimate implementation behavior prevents the successful completion of an (otherwise) applicable test. Examples of such

modifications include: adding a length clause to alter the default size of a collection; splitting a Class B test into sub-tests so that all errors are detected; and confirming that messages produced by an executable test demonstrate conforming behavior that wasn't anticipated by the test (such as raising one exception instead of another).

Modifications were required for 69 Class B tests.

The following Class B test files were split because syntax errors at one point resulted in the compiler not detecting other errors in the test:

|          |           |          |          |
|----------|-----------|----------|----------|
| B22003A  | B26001A   | B26002A  | B26005A  |
| B28001D  | B29001A   | B2A003A  | B2A003B  |
| B2A003C  | B33301A   | B35101A  | B37106A  |
| B37301B  | B37302A   | B38003A  | B38003B  |
| B38009A  | B38009B   | B51001A  | B53009A  |
| B54A01C  | B55A01A   | B61001C  | B61001D  |
| B61001F  | B61001H   | B61001I  | B61001M  |
| B61001R  | B61001S   | B61001W  | B67001A  |
| B67001C  | B67001D   | B91001A  | B91002A  |
| B91002B  | B91002C   | B91002D  | B91002E  |
| B91002F  | B91002G   | B91002H  | B91002I  |
| B91002J  | B91002K   | B91002L  | B95030A  |
| B95061A  | B95061F   | B95061G  | B95077A  |
| B97101A  | B97101E   | B97102A  | B97103E  |
| B97104G  | BA1101BOM | BA1101B1 | BA1101B2 |
| BA1101B3 | BA1101B4  | BC10AEB  | BC1109A  |
| BC1109C  | BC1109D   | BC1202A  | BC1202B  |
| BC1202E  | BC1202F   | BC1202G  | BC2001D  |
| BC2001E  |           |          |          |

C34007A, C34007D, C34007G, C34007M, C34007P, C34007S these tests contain the application of the attribute STORAGE\_SIZE to access types for which no corresponding STORAGE\_SIZE length clause has been provided; this compiler rejects such an application. The AVO accepted this behavior because the Ada standard is not clear on how such a situation should be treated; the matter will be discussed by the language maintenance body. For this implementation, the lines within each of these tests which have the STORAGE\_SIZE length clause were changed to comment lines under the direction of the AVF Manager. These modified tests ran to a successful completion and produced a PASSED message.

### 3.7 ADDITIONAL TESTING INFORMATION

#### 3.7.1 Prevalidation

Prior to validation, a set of test results for ACVC Version 1.9 produced by the DACS-386/UNIX was submitted to the AVF by the applicant for review. Analysis of these results demonstrated that the compiler successfully passed all applicable tests, and the compiler exhibited the expected behavior on all inapplicable tests.

### 3.7.2 Test Method

Testing of the DACS-386/UNIX using ACVC Version 1.9 was conducted on-site by a validation team from the AVF. The configuration consisted of a VAX-11/8530 computer (20 Mbytes RAM; 4 456 Mbytes disk drives; 24 terminal ports; 1 1600/6250 bpi tape-drive) operating under VMX Version 4.5 onto which was loaded the magnetic tape, a SUN-3 Workstation operating under UNIX V Rel. 1.0.4 which served to transfer the test files onto a streamer tape, and RC900 (386/UNIX V Workstation) which served as the host/target computer. The VAX-11/8530 was linked via an Ethernet LAN to the SUN-3 Workstation.

A magnetic tape containing all tests except for withdrawn tests was taken on-site by the validation team for processing. Tests that make use of implementation-specific values were customized before being written to the magnetic tape. The contents of the magnetic tape were loaded directly onto the VAX-11/8530, then downloaded via an Ethernet LAN to the SUN UNIX Workstation and then downloaded to the SUN-3 Workstation and then via a streamer tape to the RC900 (386/UNIX V Workstation). The contents of this streamer tape was loaded onto the RC900 (386/UNIX V Workstation).

After the test files were loaded to disk on the RC900 (386/UNIX V Workstation), the full set of tests was compiled, and all executable tests were linked and executed on the RC900 (386/UNIX V Workstation). Results were copied onto a streamer tape which was then transferred to the SUN-3 Workstation. The results were then transferred via the Ethernet LAN to the VAX-11/8530. The results were then printed from the VAX-11/8530 computer.

The compiler was tested using command scripts provided by DDC-I, Inc. and reviewed by the validation team. The compiler was tested using all default option | switch settings except for the following:

| <u>Option   Switch</u> | <u>Effect.</u>   |
|------------------------|--|
| -L                     | List option  |
| -l                     | Name of the program library; both the default values and explicitly specified program libraries were used. |

Tests were compiled, linked, and executed using the same Host/Target computer. Test output, compilation listings, and job logs were captured on magnetic tape and archived at the AVF.

### 3.7.3 Test Site

Testing was conducted at Copenhagen, Denmark and was completed on 28 July 1988.





APPENDIX A  
CONFORMANCE STATEMENT

## APPENDIX A

### CONFORMANCE STATEMENT

DDC International A/S has submitted the following Declaration of Conformance statement concerning the DACS-386/UNIX.

#### DECLARATION OF CONFORMANCE

Compiler Implementor: DDC International A/S  
Ada Validation Facility:


Software Standards Validation Group  
Institute for Computer Sciences and Technology  
National Bureau of Standards  
Building 225, Room A266  
Gaithersburg, Maryland 20899

#### Base Configuration

Base Compiler Name: DACS-386/UNIX, Version: 4.2  
Host Architecture ISA: RC900 OS&VER #: UNIX V Rel 1.0.4  
Target Architecture ISA: RC900 OS&VER #: UNIX V Rel 1.0.4

#### Implementor's Declaration

I, the undersigned, representing DDC International A/S, have implemented no deliberate extensions to the Ada Language Standard ANSI/MIL-STD-1815A in the compiler(s) listed in this declaration. I declare that DDC International A/S is the owner of record of the Ada language compiler(s) listed above and, as such, is responsible for maintaining said compiler(s) in conformance to ANSI/MIL-STD-1815A. All certificates and registrations for Ada language compiler(s) listed in this declaration shall be made only in the owner's name.



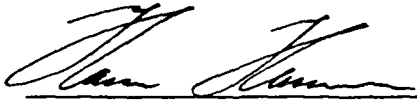
---

Date: 26 July 1988

DDC International A/S  
Hasse Hansson, Department Manager, Product Development

Owner's Declaration

I, the undersigned, representing DDC International A/S, take full responsibility for implementation and maintenance of the Ada compiler(s) listed above, and agree to the public disclosure of the final Validation Summary Report. I further agree to continue to comply with the Ada trademark policy, as defined by the Ada Joint Program Office. I declare that all of the Ada language compilers listed, and their host/target performance are in compliance with the Ada Language Standard ANSI/MIL-STD-1815A.



Date: 26 July 1988

DDC International A/S  
Hasse Hansson, Department Manager, Product Development

## APPENDIX B

### APPENDIX F OF THE Ada STANDARD

The only allowed implementation dependencies correspond to implementation-dependent pragmas, to certain machine-dependent conventions as mentioned in chapter 13 of MIL-STD-1815A, and to certain allowed restrictions on representation clauses. The implementation-dependent characteristics of the DACS-386/UNIX, Version 4.2, are described in the following sections which discuss topics in Appendix F of the Ada Language Reference Manual (ANSI/MIL-STD-1815A).. Implementation-specific portions of the package STANDARD are also included in this appendix.

package STANDARD is

```
type INTEGER is range -2_147_483_648 .. 2_147_483_647;
type SHORT_INTEGER is range -32_768 .. 32_767;
type LONG_INTEGER is range
    -16#8000_0000_0000# .. 16#7FFF_FFFF_FFFF_FFFF#;

type FLOAT is digits 6 range
    -3.40282366920938E38 .. 3.40282366920938E38;
type LONG_FLOAT is digits 15 range
    -1.7976931348623157E308 .. 1.7976931348623157E308;
type DURATION is delta 2#1.0#E-14 range -131_072.0 .. 131_071.0;
```



**DDC-I Ada Compiler System™**  
**User's Guide**  
**for DACS-386/UNIX™**

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November 15, 1988

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## APPENDIX F IMPLEMENTATION-DEPENDENT CHARACTERISTICS

---

This appendix describes the implementation-dependent characteristics of DACS-386/UNIX™ as required in Appendix F of the Ada Reference Manual (ANSI/MIL-STD-1815A).

### F.1 Implementation-Dependent Pragmas

This section describes all implementation defined pragmas.

#### F.1.1 Pragma INTERFACE\_SPELLING

This pragma allows an Ada program to call a non-Ada program whose name contains characters that would be an invalid Ada subprogram identifier. This pragma must be used in conjunction with pragma INTERFACE, i.e., pragma INTERFACE must be specified for the non-Ada subprogram name prior to using pragma INTERFACE\_SPELLING.

The pragma has the format:

```
pragma INTERFACE_SPELLING (subprogram name, string literal);
```

where the subprogram name is that of one previously given in pragma INTERFACE and the string literal is the exact spelling of the interfaced subprogram in its native language. This pragma is only required when the subprogram name contains invalid characters for Ada identifiers.

#### F.1.2 Pragma INTERRUPT\_HANDLER

The DACS-386/UNIX™ allows the use of pragma INTERRUPT\_HANDLER for compatibility with other DACS compiler systems. In this implementation this pragma does not have any affect in the Ada program. The following information is reference only. It has the format:

```
pragma INTERRUPT_HANDLER;
```

The pragma must appear as the first thing in the specification of the task object. The task must be specified in a package and not a procedure.

#### F.1.3 Pragma LT\_STACK\_SPACE

This pragma sets the size of a library task stack segment. The pragma has the format:

```
pragma LT_STACK_SPACE (T, N);
```



## User's Guide Implementation Dependent Characteristics

where T denotes either a task object or task type and N designates the size of the library task stack segment in words.

The size of the library task stack is normally specified via the representation clause:

for T STORAGE\_SIZE use N;

The size of the library task stack segment determines how many tasks can be created which are nested within the library task. All tasks created within a library task will have their stacks allocated from the same segment as the library task stack. Thus, pragma LT\_STACK\_SPACE must be specified to reserve space within the library task stack segment so that nested tasks' stacks may be allocated.

The following restrictions are places on the use of LT\_STACK\_SPACE:

- 1) It must be used only for library tasks.
- 2) It must be placed immediately after the task object or type name declaration.
- 3) The library task stack segment size (N) must be greater than or equal to the library task stack size.

### F.2 Implementation-Dependent Attributes

No implementation-dependent attributes are defined.



### F.3 Package System

The package System for DACS-386/UNIX™ is:

package System is

```
type Word is new Short_Integer;
type DWord is new Integer;
type QWord is new Long_Integer;
type UnsignedWord is range 0..65535;
for UnsignedWord'SIZE use 16;
type UnsignedDword is range 0..16#7FFF_FFFF#;
for UnsignedDword'SIZE use 32;

type Address is record
  offset : UnsignedDword;
end record;

subtype Priority is Word range 0..31;
type Name is (386UNIX);

System_Name : constant Name := 386UNIX;
Storage_Unit : constant := 16;
Memory_Size : constant := 2**32;
Min_Int : constant := -16#8000_0000_0000_0000#;
Max_Int : constant := 16#7FFF_FFFF_FFFF_FFFF#;
Max_Digits : constant := 15;
Max_Mantissa : constant := 31;
Fine_Delta : constant := 2#1.0#E-31;
Tick : constant := 0.000_000_062_5;
--machine dependant

type Interface_Language is (ASM86, C86, C86_REVERSE);
type ExceptionId is record
  unit_number : UnsignedDword;
  unique_number : UnsignedDword;
end record;

type TaskValue is new Integer;
type AccTaskValue is access TaskValue;

type Semaphore is record
  counter : UnsignedWord;
  first : TaskValue;
  last : TaskValue;
end record;

InitSemaphore : constant Semaphore'(1, 0, 0);

end SYSTEM;
```





## F.4 Representation Clauses

The DACS-386/UNIX™ fully supports the 'SIZE representation for derived types. The representation clauses that are accepted for non-derived types are described in the following subsections.

### F.4.1 Length Clause

Some remarks on implementation dependent behavior of length clauses are necessary:

- When using the SIZE attribute for discrete types, the maximum value that can be specified is 16 bits.
- SIZE is only obeyed for discrete types when the type is a part of a composite object, e.g. arrays or records, for example:

```
type byte is range 0..255;  
for byte'size use 8;
```

```
sixteen_bits_allocated : byte;           -- one word allocated
```

```
eight_bit_per_element : array(0..7) of byte; -- four words allocated
```

```
type rec is record  
  c1,c2 : byte;           -- eight bits per component  
end record;
```

- Using the STORAGE\_SIZE attribute for a collection will set an upper limit on the total size of objects allocated in this collection. If further allocation is attempted, the exception STORAGE\_ERROR is raised.
- When STORAGE\_SIZE is specified in a length clause for a task, the process stack area will be of the specified size. The process stack area will be allocated inside the "standard" stack segment.

### F.4.2 Enumeration Representation Clause

Enumeration representation clauses may specify representations in the range of INTEGER'FIRST + 1..INTEGER'LAST - 1.

### F.4.3 Record Representation Clauses

When representation clauses are applied to records the following restrictions are imposed:

- the component type is a discrete type different from LONG\_INTEGER



## User's Guide Implementation Dependent Characteristics

- the component type is an array with a discrete element type different from LONG\_INTEGER
- the storage unit is 16 bits
- a record occupies an integral number of storage units
- a record may take up a maximum of 32K storage units
- a component must be specified with its proper size (in bits), regardless of whether the component is an array or not.
- if a non-array component has a size which equals or exceeds one storage unit (16 bits) the component must start on a storage unit boundary, i.e. the component must be specified as:

component at N range  $0..16 * M - 1$ ;

where N specifies the relative storage unit number (0,1,...) from the beginning of the record, and M the required number of storage units (1,2,...)

- the elements in an array component should always be wholly contained in one storage unit
- if a component has a size which is less than one storage unit, it must be wholly contained within a single storage unit:

component at N range  $X .. Y$ ;

where N is as in previous paragraph, and  $0 \leq X \leq Y \leq 15$

When dealing with PACKED ARRAY the following should be noted:

- the elements of the array are packed into 1,2,4 or 8 bits

If the record type contains components which are not covered by a component clause, they are allocated consecutively after the component with the value. Allocation of a record component without a component clause is always aligned on a storage unit boundary. Holes created because of component clauses are not otherwise utilized by the compiler.

### F.4.3.1 Alignment Clauses

The DACS-386/UNIX™ allows the use of alignment clauses for compatibility with other DACS Ada Compiler Systems. In this implementation, however, these representation clauses do not actually modify the internal data representation of objects. The following information is provided to show the allowed syntax for the representation clauses.



## **F.5 Implementation-Dependent Names for Implementation-Dependent Components**

None defined by the compiler.

## **F.6 Address Clauses**

This section describes the implementation of address clauses and what types of entities may have their address specified by the user. In the DACS 386/UNIX<sup>TM</sup> implementation, address clauses are allowed to provide compatibility with other DACS Ada Compiler Systems, although they do not actually affect the data representation.

### **F.6.1 Task Entries**

The implementation supports two methods to equate a task entry to a hardware interrupt through an address clause:

- 1) Direct transfer of control to a task accept statement when an interrupt occurs (requires use of the pragma `INTERRUPT_HANDLER`).
- 2) Mapping of an interrupt onto a normal conditional entry call, i.e., the entry can be called from other tasks without special actions, as well as being called when an interrupt occurs.

## **F.7 Unchecked Conversions**

Unchecked conversion is only allowed between objects of the same "size".



## F.8 Input/Output Packages

The implementation supports all requirements of the Ada language. It is an effective interface to the UNIX file system, and in the case of the text I/O also an effective interface to the UNIX standard input, standard output and standard error streams.

This section describes the functional aspects of the interface to the UNIX file system, including the methods of using the interface to take advantage of the file control facilities provided.

The Ada input-output concept as defined in Chapter 14 of the ARM does not constitute a complete functional specification of the input-output packages. Some aspects of the I/O system are not described at all, with others intentionally left open for implementation. This section describes those sections not covered in the ARM.

The UNIX operating system considers all files to be raw sequences of characters. Files can either be accessed sequentially or randomly. Files are not structured into records, but an access routine can treat a file as a sequence of records if it arranges the record level input-output. Two restrictions that apply are:

- If a direct access (using `lseek(2)`) to standard input, standard output, or standard error will cause a `USE_ERROR` to occur.
- Attempting to direct access (using `lseek(2)`, `open(2)`, `mknod(2)`, or `pipe(2)`) a UNIX pipe or FIFO will cause a `USE_ERROR` to occur.

Note that for sequential or text files (Ada files not UNIX external files) `RESET` on a file in mode `OUT_FILE` will empty the file. Also, a sequential or text file opened as an `OUT_FILE` will be emptied.

### F.8.1 External Files

An external file is either a UNIX disk file, a UNIX FIFO, a UNIX pipe, or any device defined in the UNIX directory. The use of devices such as a tape drive or communication line may require special access permissions or have restrictions. If an inappropriate operation is attempted on a device, the `USE_ERROR` exception is raised.

External files created within the UNIX file system shall exist after the termination of the program that created it, and will be accessible from other Ada programs. A form created with the `FORM` parameter will also exist after program termination. However, pipes and temporary files will not exist after program termination.

Creation of a file with the same name as an existing external file will cause the exception `USE_ERROR` to be raised. Also, creation of files with mode `IN_FILE` will raise `USE_ERROR`.

The name parameter to the input/output routines must be a valid UNIX file name. If the name parameter is empty then a temporary file is created in the `/tmp` directory. This file is automatically deleted when the program that created it terminates.



### F.3.2 File Management

This section provides useful information for performing file management functions within an Ada program.

The only restrictions in performing Sequential and Direct I/O are:

- The maximum size of an object of `ELEMENT_TYPE` is 32k bytes.
- If the size of an object of `ELEMENT_TYPE` is variable, the maximum size must be determinable at the point of instantiation from the value of the `SIZE` attribute.

#### The NAME parameter

The NAME parameter must be a valid UNIX pathname (unless null). If any directory in the pathname is inaccessible, a `USE_ERROR` is raised.

The UNIX names "stdin", "stdout", and "stderr" can be used with `TEXT_IO.OPEN`. No physical opening of the external file is performed and the Ada file will be associated with already open external file. These names have no significance for other packages.

Temporary files (NAME = null string) are created using `tmpname(3)` and are deleted when `CLOSED`. Abnormal program termination may leave temporary files in existence.

#### The FORM parameter

The FORM parameter has the following facilities:

- A FIFO special file can be opened using the `open(2)` system call. This is achieved with the "FIFO" string. Note that this cannot be used with `CREATE`.

The default value for this facility is "ORDINARY", which designates the creation of an ordinary file.

An additional flag associated with FIFO specials is provided to allow waiting or immediate return. This flag, and its status, is specified with the additional strings, "O\_NDELAY=ON" for ON and "O\_NDELAY=OFF" for OFF. Default is "O\_NDELAY=OFF".

- The "APPEND" string can be used to open text files without emptying the file. This parameter cannot be used with `CREATE`. The default condition is "NOAPPEND".
- Access rights to a file can be controlled by using a "MODE=<mode>" string in the `CREATE` procedure. <mode> is an octal, decimal, or hexadecimal integer in the standard UNIX format. Default mode is 0644. This facility can also be used by `OPEN` to change access permissions on existing files by means of the `chmod(2)` system call.



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If more than one of the three options (FIFO, APPEND, and MODE) is included, the rightmost option is selected. Blanks are not significant within any part of the string. The syntax of the FORM parameter provides all default options as required in the Ada Reference Manual:

`<form_parameter> := [<option> ,...]`

where `<option>` := `<access_rights>` | `<fifo>` | `<append>`

`<access_rights>` is `MODE=<mode #>`. The mode number can be in decimal, octal (0###), or hexadecimal (0##).

`<fifo>` is either "FIFO [O\_NDELAY= ON/OFF]" or "ORDINARY"

`<append>` is either "APPEND" or "NOAPPEND"

### File Access

The following guidelines should be observed when performing file I/O operations:

- At a given instant, any number of files in an Ada program can be associated with corresponding external files.
- When sharing files between programs, it is the responsibility of the programmer to determine the effects of sharing files.
- The RESET and OPEN operations to files of mode OUT\_FILE will empty the contents of the file in SEQUENTIAL\_IO and TEXT\_IO.
- Files can be interchanged between SEQUENTIAL\_IO and DIRECT\_IO without any special operations, if the files are the same object type.



### F.8.3 Package TEXT\_IO

The specification of package TEXT\_IO:

with BASIC\_IO\_TYPES;

with IO\_EXCEPTIONS;

package TEXT\_IO is

type FILE\_TYPE is limited private;

type FILE\_MODE is (IN\_FILE, OUT\_FILE);

type COUNT is range 0 .. LONG\_INTEGER'LAST;

subtype POSITIVE\_COUNT is COUNT range 1 .. COUNT'LAST;

UNBOUNDED: constant COUNT:= 0; -- line and page length

-- max. size of an integer output field 2#....#

subtype FIELD is INTEGER range 0 .. 35;

subtype NUMBER\_BASE is INTEGER range 2 .. 16;

type TYPE\_SET is (LOWER\_CASE, UPPER\_CASE);

-- File Management

```
procedure CREATE (FILE      : in out FILE_TYPE;
                  MODE      : in   FILE_MODE := OUT_FILE;
                  NAME      : in   STRING    := "";
                  FORM      : in   STRING    := ""
                  );
```

```
procedure OPEN ( FILE      : in out FILE_TYPE;
                MODE      : in   FILE_MODE;
                NAME      : in   STRING;
                FORM      : in   STRING := ""
                );
```

```
procedure CLOSE (FILE : in out FILE_TYPE);
procedure DELETE (FILE : in out FILE_TYPE);
procedure RESET (FILE : in out FILE_TYPE; MODE : in FILE_MODE);
procedure RESET (FILE : in out FILE_TYPE);
```

```
function MODE (FILE : in FILE_TYPE) return FILE_MODE;
function NAME (FILE : in FILE_TYPE) return STRING;
function FORM (FILE : in FILE_TYPE) return STRING;
```

```
function IS_OPEN (FILE : in FILE_TYPE) return BOOLEAN;
```

-- control of default input and output files

```
procedure SET_INPUT (FILE : in FILE_TYPE);
procedure SET_OUTPUT (FILE : in FILE_TYPE);
```



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```
function STANDARD_INPUT  return FILE_TYPE;
function STANDARD_OUTPUT return FILE_TYPE;

function CURRENT_INPUT  return FILE_TYPE;
function CURRENT_OUTPUT return FILE_TYPE;

-- specification of line and page lengths

procedure SET_LINE_LENGTH (FILE : in FILE_TYPE; TO : in COUNT);
procedure SET_LINE_LENGTH (TO : in COUNT);

procedure SET_PAGE_LENGTH (FILE : in FILE_TYPE; TO : in COUNT);
procedure SET_PAGE_LENGTH (TO : in COUNT);

function LINE_LENGTH (FILE : in FILE_TYPE) return COUNT;
function LINE_LENGTH  return COUNT;

function PAGE_LENGTH (FILE : in FILE_TYPE) return COUNT;
function PAGE_LENGTH  return COUNT;

-- Column, Line, and Page Control

procedure NEW_LINE (FILE : in FILE_TYPE;
                   SPACING : in POSITIVE_COUNT := 1);
procedure NEW_LINE (SPACING : in POSITIVE_COUNT := 1);

procedure SKIP_LINE (FILE : in FILE_TYPE;
                   SPACING : in POSITIVE_COUNT := 1);
procedure SKIP_LINE (SPACING : in POSITIVE_COUNT := 1);

function END_OF_LINE (FILE : in FILE_TYPE) return BOOLEAN;
function END_OF_LINE  return BOOLEAN;

procedure NEW_PAGE  (FILE : in FILE_TYPE);
procedure NEW_PAGE;

procedure SKIP_PAGE (FILE : in FILE_TYPE);
procedure SKIP_PAGE;

function END_OF_PAGE (FILE : in FILE_TYPE) return BOOLEAN;
function END_OF_PAGE  return BOOLEAN;

function END_OF_FILE (FILE : in FILE_TYPE) return BOOLEAN;
function END_OF_FILE  return BOOLEAN;

procedure SET_COL  (FILE : in FILE_TYPE; TO : in POSITIVE_COUNT);
procedure SET_COL  (TO : in POSITIVE_COUNT);

procedure SET_LINE (FILE : in FILE_TYPE; TO : in POSITIVE_COUNT);
procedure SET_LINE (TO : in POSITIVE_COUNT);

function COL  (FILE : in FILE_TYPE) return POSITIVE_COUNT;
function COL  return POSITIVE_COUNT;
```





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```
function LINE (FILE : in FILE_TYPE) return POSITIVE_COUNT;  
function LINE return POSITIVE_COUNT;
```

```
function PAGE (FILE : in FILE_TYPE) return POSITIVE_COUNT;  
function PAGE return POSITIVE_COUNT;
```

-- Character Input-Output

```
procedure GET (FILE : in FILE_TYPE; ITEM : out CHARACTER);  
procedure GET (ITEM : out CHARACTER);  
procedure PUT (FILE : in FILE_TYPE; ITEM : in CHARACTER);  
procedure PUT (ITEM : in CHARACTER);
```

-- String Input-Output

```
procedure GET (FILE : in FILE_TYPE; ITEM : out CHARACTER);  
procedure GET (ITEM : out CHARACTER);  
procedure PUT (FILE : in FILE_TYPE; ITEM : in CHARACTER);  
procedure PUT (ITEM : in CHARACTER);
```

```
procedure GET_LINE (FILE : in FILE_TYPE;  
                   ITEM : out STRING;  
                   LAST : out NATURAL);
```

```
procedure GET_LINE (ITEM : out STRING; LAST : out NATURAL);  
procedure PUT_LINE (FILE : in FILE_TYPE; ITEM : in STRING);  
procedure PUT_LINE (ITEM : in STRING);
```



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-- Generic Package for Input-Output of Integer Types

generic

type NUM is range <> is

DEFAULT\_WIDTH : FIELD := NUM'WIDTH;  
DEFAULT\_BASE : NUMBER\_BASE := 10;

procedure GET ( FILE : in FILE\_TYPE;  
ITEM : out NUM;  
WIDTH : in FIELD := 0);

procedure GET ( ITEM : out NUM;  
WIDTH : in FIELD := 0);

procedure PUT ( FILE : in FILE\_TYPE;  
ITEM : in NUM;  
WIDTH : in FIELD := DEFAULT\_WIDTH;  
BASE : in NUMBER\_BASE := DEFAULT\_BASE);

procedure PUT ( ITEM : in NUM;  
WIDTH : in FIELD := DEFAULT\_WIDTH;  
BASE : in NUMBER\_BASE := DEFAULT\_BASE);

procedure GET ( FROM : in STRING;  
ITEM : out NUM;  
LAST : out POSITIVE);

procedure PUT ( TO : out STRING;  
ITEM : in NUM;  
BASE : in NUMBER\_BASE := DEFAULT\_BASE);

end INTEGER\_IO;



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-- Generic Packages for Input-Output of Real Types

```
generic
  type NUM is digits <>;
package FLOAT_IO is

  DEFAULT_FORE : FIELD :=      2;
  DEFAULT_AFT  : FIELD := NUM'DIGITS - 1;
  DEFAULT_EXP  : FIELD :=      3;

  procedure GET (  FILE      : in FILE_TYPE;
                   ITEM      : out NUM;
                   WIDTH     : in FIELD := 0);
  procedure GET (  ITEM      : out NUM;
                   WIDTH     : in FIELD := 0);

  procedure PUT (  FILE      : in FILE_TYPE;
                   ITEM      : in NUM;
                   FORE      : in FIELD := DEFAULT_FORE;
                   AFT       : in FIELD := DEFAULT_AFT;
                   EXP       : in FIELD := DEFAULT_EXP);
  procedure PUT (  ITEM      : in NUM;
                   FORE      : in FIELD := DEFAULT_FORE;
                   AFT       : in FIELD := DEFAULT_AFT;
                   EXP       : in FIELD := DEFAULT_EXP);

  procedure GET (  FROM      : in STRING;
                   ITEM      : out NUM;
                   LAST      : out POSITIVE);
  procedure PUT (  TO        : out STRING;
                   ITEM      : in NUM;
                   AFT       : in FIELD      := DEFAULT_AFT;
                   EXP       : in FIELD      := DEFAULT_EXP);

end FLOAT_IO;
```



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```
generic
  type NUM is delta <>;
package FIXED_IO is

  DEFAULT_FORE : FIELD := NUM'FORE;
  DEFAULT_AFT  : FIELD := NUM'AFT;
  DEFAULT_EXP  : FIELD := 0;

  procedure GET (  FILE      : in  FILE_TYPE;
                   ITEM      : out NUM;
                   WIDTH     : in  FIELD      := 0);

  procedure GET (  TEM      : out NUM;
                   WIDTH     : in  FIELD      := 0);

  procedure PUT (  FILE      : in FILE_TYPE;
                   ITEM      : in NUM;
                   FORE      : in FIELD := DEFAULT_FORE;
                   AFT       : in FIELD := DEFAULT_AFT;
                   EXP       : in FIELD := DEFAULT_EXP);

  procedure PUT (  ITEM      : in NUM;
                   FORE      : in FIELD := DEFAULT_FORE;
                   AFT       : in FIELD := DEFAULT_AFT;
                   EXP       : in FIELD := DEFAULT_EXP);

  procedure GET (  FROM      : in STRING;
                   ITEM      : out NUM;
                   LAST      : out POSITIVE);

  procedure PUT (  TO        : out STRING;
                   ITEM      : in NUM;
                   AFT       : in FIELD := DEFAULT_AFT;
                   EXP       : in FIELD := DEFAULT_EXP);

end FIXED_IO;
```



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-- Generic Package for Input-Output of Enumeration Types

```
generic
  type ENUM is (<>);
package ENUMERATION_IO is

  DEFAULT_WIDTH      : FIELD      := 0;
  DEFAULT_SETTING    : TYPE_SET   := UPPER_CASE;

  procedure GET (   FILE : in FILE_TYPE; ITEM : out ENUM);
  procedure GET (   ITEM: out ENUM);

  procedure PUT (   FILE      : FILE_TYPE;
                    ITEM      : in ENUM;
                    WIDTH     : in FIELD      := DEFAULT_WIDTH;
                    SET       : in TYPE_SET   := DEFAULT_SETTING);
  procedure PUT (   ITEM      : in ENUM;
                    WIDTH     : in FIELD      := DEFAULT_WIDTH;
                    SET       : in TYPE_SET   := DEFAULT_SETTING);

  procedure GET (   FROM      : in STRING;
                    ITEM      : out ENUM;
                    LAST      : out POSITIVE);

  procedure PUT (   TO        : out STRING;
                    ITEM      : in ENUM;
                    SET       : in TYPE_SET   := DEFAULT_SETTING);

end ENUMERATION_IO;

-- Exceptions

STATUS_ERROR : exception renames IO_EXCEPTIONS.STATUS_ERROR;
MODE_ERROR   : exception renames IO_EXCEPTIONS.MODE_ERROR;
NAME_ERROR   : exception renames IO_EXCEPTIONS.NAME_ERROR;
USE_ERROR    : exception renames IO_EXCEPTIONS.USE_ERROR;
DEVICE_ERROR : exception renames IO_EXCEPTIONS.DEVICE_ERROR;
END_ERROR    : exception renames IO_EXCEPTIONS.END_ERROR;
DATA_ERROR   : exception renames IO_EXCEPTIONS.DATA_ERROR;
LAYOUT_ERROR : exception renames IO_EXCEPTIONS.LAYOUT_ERROR;

private

  type FILE_TYPE is new BASIC_IO_TYPES.FILE_TYPE;

end TEXT_IO;
```



#### F.8.4 Package LOW\_LEVEL\_IO

The specification of LOW\_LEVEL\_IO is:

with SYSTEM;

package LOW\_LEVEL\_IO is

    subtype port\_address is System.Word;

    type byte is new integer;

    procedure send\_control (device : in port\_address; data : in System.Word);

    procedure send\_control (device : in port\_address; data : in byte);

    procedure receive\_control (device : in port\_address; data : out byte);

    procedure receive\_control (device : in port\_address; data : out System.Word);

    private

        pragma inline (send\_control, receive\_control);

end LOW\_LEVEL\_IO;



### F.8.5 Package SEQUENTIAL\_IO

In SEQUENTIAL\_IO, type checking for DATA\_ERROR has been excluded for elements are an unconstrained type.

- Source code for SEQUENTIAL\_IO

with IO\_EXCEPTIONS;

generic

type ELEMENT\_TYPE is private;

package SEQUENTIAL\_IO is

type FILE\_TYPE is limited private;

type FILE\_MODE is (IN\_FILE, OUT\_FILE);

-- File management

```
procedure CREATE(FILE : in out FILE_TYPE;
                 MODE : in FILE_MODE := OUT_FILE;
                 NAME : in STRING := "";
                 FORM : in STRING := "");
```

```
procedure OPEN ( FILE : in out FILE_TYPE;
                 MODE : in FILE_MODE;
                 NAME : in STRING;
                 FORM : in STRING := "");
```

```
procedure CLOSE (FILE : in out FILE_TYPE);
```

```
procedure DELETE(FILE : in out FILE_TYPE);
```

```
procedure RESET (FILE : in out FILE_TYPE; MODE : in FILE_MODE);
```

```
procedure RESET (FILE : in out FILE_TYPE);
```

```
function MODE (FILE : in FILE_TYPE) return FILE_MODE;
```

```
function NAME (FILE : in FILE_TYPE) return STRING;
```

```
function FORM (FILE : in FILE_TYPE) return STRING;
```

```
function IS_OPEN(FILE : in FILE_TYPE) return BOOLEAN;
```

-- input and output operations

```
procedure READ ( FILE : in FILE_TYPE;
                 ITEM : out ELEMENT_TYPE);
```



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```
procedure WRITE ( FILE      : in FILE_TYPE;  
                 ITEM      : in ELEMENT_TYPE);  
  
function END_OF_FILE(FILE : in FILE_TYPE) return BOOLEAN;  
  
-- exceptions  
  
STATUS_ERROR : exception renames IO_EXCEPTIONS.STATUS_ERROR;  
MODE_ERROR   : exception renames IO_EXCEPTIONS.MODE_ERROR;  
NAME_ERROR   : exception renames IO_EXCEPTIONS.NAME_ERROR;  
USE_ERROR    : exception renames IO_EXCEPTIONS.USE_ERROR;  
DEVICE_ERROR : exception renames IO_EXCEPTIONS.DEVICE_ERROR;  
END_ERROR    : exception renames IO_EXCEPTIONS.END_ERROR;  
DATA_ERROR   : exception renames IO_EXCEPTIONS.DATA_ERROR;  
  
private  
  
type FILE_TYPE is new BASIC_IO_TYPES.FILE_TYPE;  
  
end SEQUENTIAL_IO;
```





### F.8.6 Package Direct\_IO

In `DIRECT_IO`, type checking for `DATA_ERROR` has been excluded for elements of an unconstrained type.

```
with BASIC_IO_TYPES;  
with IO_EXCEPTIONS;
```

generic

```
type ELEMENT_TYPE is private;
```

package `DIRECT_IO` is

```
type FILE_TYPE is limited private;
```

```
type FILE_MODE is (IN_FILE, INOUT_FILE, OUT_FILE);
```

```
type COUNT is range 0..LONG_INTEGER'LAST;
```

```
subtype POSITIVE_COUNT is COUNT range 1..COUNT'LAST;
```

-- File management

```
procedure CREATE(FILE : in out FILE_TYPE;  
                 MODE : in FILE_MODE := INOUT_FILE;  
                 NAME : in STRING := "";  
                 FORM : in STRING := "");
```

```
procedure OPEN ( FILE : in out FILE_TYPE;  
                MODE : in FILE_MODE;  
                NAME : in STRING;  
                FORM : in STRING := "");
```

```
procedure CLOSE(FILE : in out FILE_TYPE);
```

```
procedure DELETE(FILE : in out FILE_TYPE);
```

```
procedure RESET(FILE : in out FILE_TYPE;  
                MODE : in FILE_MODE);
```

```
procedure RESET(FILE : in out FILE_TYPE);
```

```
function MODE (FILE : in FILE_TYPE) return FILE_MODE;
```

```
function NAME (FILE : in FILE_TYPE) return STRING;
```

```
function FORM (FILE : in FILE_TYPE) return STRING;
```

```
function IS_OPEN(FILE : in FILE_TYPE) return BOOLEAN;
```



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-- input and output operations

```
procedure READ ( FILE   : in      FILE_TYPE;
                  ITEM   : out     ELEMENT_TYPE;
                  FROM    : in      POSITIVE_COUNT);
procedure READ ( FILE   : in      FILE_TYPE;
                  ITEM   : out     ELEMENT_TYPE);
```

```
procedure WRITE ( FILE   : in      FILE_TYPE;
                  ITEM   : in      ELEMENT_TYPE;
                  TO      : in      POSITIVE_COUNT);
procedure WRITE ( FILE   : in      FILE_TYPE;
                  ITEM   : in      ELEMENT_TYPE);
```

```
procedure SET_INDEX(FILE : in FILE_TYPE;
                    TO   : in POSITIVE_COUNT);
```

```
function INDEX(FILE : in FILE_TYPE) return POSITIVE_COUNT;
```

```
function SIZE (FILE : in FILE_TYPE) return COUNT;
```

```
function END_OF_FILE(FILE : in FILE_TYPE) return BOOLEAN;
```

-- exceptions

```
STATUS_ERROR : exception renames IO_EXCEPTIONS.STATUS_ERROR;
MODE_ERROR   : exception renames IO_EXCEPTIONS.MODE_ERROR;
NAME_ERROR   : exception renames IO_EXCEPTIONS.NAME_ERROR;
USE_ERROR    : exception renames IO_EXCEPTIONS.USE_ERROR;
DEVICE_ERROR : exception renames IO_EXCEPTIONS.DEVICE_ERROR;
END_ERROR    : exception renames IO_EXCEPTIONS.END_ERROR;
DATA_ERROR   : exception renames IO_EXCEPTIONS.DATA_ERROR;
```

private

```
type FILE_TYPE is new BASIC_IO_TYPES.FILE_TYPE;
```

```
end DIRECT_IO;
```



## F.9 Machine Code Insertions

The reader should be familiar with the code generation strategy and the 80386 instruction set to fully benefit from this section.

As described in chapter 13.8 of the ARM [ 83] it is possible to write procedures containing only code statements using the predefined package MACHINE\_CODE. The package MACHINE\_CODE defines the type MACHINE\_INSTRUCTION which, used as a record aggregate, defines a machine code insertion. The following sections list the type MACHINE\_INSTRUCTION and types on which it depends, give the restrictions, and show an example of how to use the package MACHINE\_CODE.

### F.9.1 Predefined Types for Machine Code Insertions

The following types are defined for use when making machine code insertions (their type declarations are given in the following pages):

```
type opcode_type
type operand_type
type register_type
type segment_register
type machine_instruction
```

The type REGISTER\_TYPE defines registers and register combinations. The double register combinations (e.g. BX\_SI) can be used only as address operands (BX\_SI describing [BX+SI]). The registers STi describe registers on the floating stack. (ST is the top of the floating stack).

The type SEGMENT\_REGISTER defines the four segment registers that can be used to overwrite default segments in an address operand.

The type MACHINE\_INSTRUCTION is a discriminant record type with which every kind of instruction can be described. Symbolic names may be used in the form

```
name'ADDRESS
```

```
type opcode_type is (
```

```
  -- 8086 instructions:
```

|         |          |         |        |
|---------|----------|---------|--------|
| m_AAA,  | m_AAD,   | m_AAM,  | m_AAS, |
| m_ADC,  | m_ADD,   | m_AND,  |        |
| m_CALL, | m_CALLn, |         |        |
| m_CBW,  | m_CLC,   | m_CLD   | m_CLI, |
| m_CMC,  | m_CMP,   | m_CMPS, | m_CWD, |
| m_DAA,  | m_DAS,   |         |        |
| m_DEC,  | m_DIV,   | m_HLT,  |        |
| m_IDIV, | m_IMUL,  | m_IN,   | m_INC, |
| m_INT,  | m_INT0,  | m_IRET, |        |
| m_JA,   | m_JAE,   | m_JB,   | m_JBE, |
| m_JC,   | m_JCXZ,  | m_JE,   | m_JG,  |
| m_JGE,  | m_JL,    | m_JLE,  | m_JNA, |



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|          |          |           |           |
|----------|----------|-----------|-----------|
| m_JNAE,  | m_JNB,   | m_JNBE,   | m_JNC     |
| m_JNE,   | m_JNG,   | m_JNGE,   | m_JNL,    |
| m_JNLE,  | m_JNO,   | m_JNP,    | m_JNS,    |
| m_JNZ,   | m_JO,    | m_JP,     | m_JPE,    |
| m_JPO,   | m_JS,    | m_JZ,     | m_JMP,    |
| m_LAHF,  | m_LDS,   | m_LES,    | m_LEA,    |
| m_LOCK,  | m_LODS,  |           |           |
| m_LOOP,  | m_LOOPE, | m_LOOPNE, | m_LOOPNZ, |
| m_LOOPZ, | m_MOV,   | m_MOVS,   | m_MUL,    |
| m_NEG,   | m_NOP,   | m_NOT,    | m_OR,     |
| m_OUT,   | m_POP,   | m_POPF,   | m_PUSH,   |
| m_PUSHF, |          |           |           |
| m_RCL,   | m_RCR,   | m_ROL,    | m_ROR,    |
| m_REP,   | m_REPE,  | m_REPNE,  |           |
| m_RET,   | m_RETP,  | m_RETN,   | m_RETNP,  |
| m_SAHF,  |          |           |           |
| m_SAL,   | m_SAR,   | m_SHL,    | m_SHR,    |
| m_SBB,   | m_SCAS,  |           |           |
| m_STC,   | m_STD,   | m_STI,    | m_STOS,   |
| m_SUB,   | m_TEST,  | m_WAIT,   | m_XCHG,   |
| m_XLAT,  | m_XOR,   |           |           |

--- 8087/80187/80287 Floating Point Processor instructions

|            |            |             |            |
|------------|------------|-------------|------------|
| m_FABS,    | m_FADD,    | m_FADDD,    | m_FADDP,   |
| m_FBLD,    | m_FBSTP,   | m_FCHS,     | m_FNCLEX,  |
| m_FCOM,    | m_FCOMD,   | m_FCOMP,    | m_FCOMPDP, |
| m_FCOMPP,  | m_FDECSTP, | m_FDIV,     | m_FDIVD,   |
| m_FDIVP,   | m_FDIVR,   | m_FDIVRD,   | m_FDIVRP,  |
| m_FFREE,   | m_FIADD,   | m_FIADDD,   | m_FICOM,   |
| m_FICOMD,  | m_FICOMP,  | m_FICOMPDP, | m_FIDIV,   |
| m_FIDIVD,  | m_FIDIVR,  | m_FIDIVRD,  |            |
| m_FILD,    | m_FILDD,   | m_FILDL,    | m_FIMUL,   |
| m_FIMULD,  | m_FINCSTP, | m_FNINIT,   | m_FIST,    |
| m_FISTD,   | m_FISTP,   | m_FISTPD,   | m_FISTPL,  |
| m_FISUB,   |            |             |            |
| m_FISUBD,  | m_FISUBR,  | m_FISUBRD,  | m_FLD,     |
| m_FLDD,    | m_FLDCW,   | m_FLDENV,   | m_FLDLG2,  |
| m_FLDLN2,  | m_FLDL2E,  | m_FLDL2T,   | m_FLDPI,   |
| m_FLDZ,    | m_FLD1,    | m_FMUL,     | m_FMULD,   |
| m_FMULP,   | m_FNOP,    | m_FPATAN,   | m_FPREM,   |
| m_FPTAN,   | m_FRNDINT, | m_FRSTOR,   | m_FSAVE,   |
| m_FSCALE,  | m_FSETPM,  | m_FSQRT,    |            |
| m_FST,     | m_FSTD,    | m_FSTCW,    |            |
| m_FSTENV,  | m_FSTP,    | m_FSTPD,    | m_FSTSW,   |
| m_FSTSWAX, | m_FSUB,    | m_FSUBD,    | m_FSUBP,   |
| m_FSUBR,   | m_FSUBRD,  | m_FSUBRP,   | m_FTST,    |
| m_FWAIT,   | m_FXAM,    | m_FXCH,     | m_FXTRACT, |
| m_FYL2X,   | m_FYL2XP1, | m_F2XM1,    |            |



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- 80186/80286/80386 instructions:
- Notice that some immediate versions of the 8086 instructions
- only exist on these targets (shifts, rotates, push, imul, ...)

|          |          |          |         |
|----------|----------|----------|---------|
| m_BOUND, | m_CLTS,  | m_ENTER, | m_INS,  |
| m_LAR,   | m_LEAVE, | m_LGDT,  | m_LIDT  |
| m_LSL    | m_OUTS   | m_POPA,  | m_PUSHA |
| m_SGDT,  | m_SIDT,  |          |         |
| m_ARPL,  | m_LLDT,  | m_LMSW,  | m_LTR,  |
| m_SLDT,  | m_SMSW,  | m_STR,   | m_VERR, |
| m_VERW,  |          |          |         |

- the 80386 specific instructions:

|          |           |          |           |
|----------|-----------|----------|-----------|
| m_SETA,  | m_SETAE,  | m_SETB,  | m_SETBE,  |
| m_SETC,  | m_SETE,   | m_SETG,  | m_SETGE,  |
| m_SETL,  | m_SETLE,  | m_SETNA, | m_SETNAE, |
| m_SETNB, | m_SETNBE, | m_SETNC, | m_SETNE,  |
| m_SETNG, | m_SETNGE, | m_SETNL, | m_SETNLE, |
| m_SETNO, | m_SETNP,  | m_SETNS, | m_SETNZ,  |
| m_SETO,  | m_SETP,   | m_SETPE, | m_SETPO,  |
| m_SETS,  | m_SETZ,   |          |           |

|          |          |          |        |
|----------|----------|----------|--------|
| m_BSF,   | m_BSR,   |          |        |
| m_BT,    | mBTC,    | m_BTR,   | m_BTS, |
| m_LFS,   | m_LGS,   | m_LSS,   |        |
| m_MOVZX  | m_MOVSX, |          |        |
| m_MOVCR, | m_MOVDB, | m_MOVTR, |        |
| m_SHLD,  | M_SHRD,  |          |        |

- the 80387 specific instructions

|           |           |           |           |
|-----------|-----------|-----------|-----------|
| m_FUCOM,  | m_FUCOMP, | m_FUCOMPP |           |
| m_FPREM1, | m_FSIN,   | m_FCOS,   | m_FSINCOS |



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-- byte/word/dword variants (to be used, when not deductible from  
-- context)

|           |           |          |
|-----------|-----------|----------|
| m_ADDCB,  | m_ADCW,   | m_ADCD,  |
| m_ADDB,   | m_ADDW,   | m_ADDD,  |
| m_ANDB,   | m_ANDW,   | m_ANDD,  |
| m_BTW,    | m_BTD,    |          |
| m_BTCW,   | m_BTCD,   |          |
| m_BTRW,   | m_BTRD,   |          |
| m_BTSW,   | m_BTSD,   |          |
| m_CBWW,   | m_CWDE,   |          |
| m_CWDW,   | m_CDQ,    |          |
| m_CMPB,   | m_CMPW,   | m_CMPD,  |
| m_CMPSB,  | m_CMPSW,  | m_CMPSD, |
| m_DECB,   | m_DECW,   | m_DECD,  |
| m_DIVB,   | m_DIVW,   | m_DIVD,  |
| m_IDIVB,  | m_IDIVW,  | m_IDIVD, |
| m_IMULB,  | m_IMULW,  | m_IMULD, |
| m_INCB,   | m_INCW,   | m_INCD,  |
| m_INSB,   | m_INSW,   | m_INSD,  |
| m_LODSB,  | m_LODSW,  | m_LOSD,  |
| m_MOVB,   | m_MOVW,   | m_MOVD,  |
| m_MOVSB,  | m_MOVSW,  | m_MOVSD, |
| m_MOVSXB, | m_MOVSXW, |          |
| m_MOVZXB, | m_MOVZXW, |          |
| m_MULB,   | m_MULW,   | m_MULD,  |
| m_NEGB,   | m_NEGW,   | m_NEGD,  |
| m_NOTB,   | m_NOTW,   | m_NOTD,  |
| m_ORB,    | m_ORW,    | m_ORD,   |
| m_OUTSB,  | m_OUTSW,  | m_OUTSD, |
| m_POPW,   | m_POPD,   |          |
| m_PUSHW,  | m_PUSD,   |          |
| m_RCLB,   | m_RCLW,   | m_RCLD,  |
| m_RCRB,   | m_RCRW,   | m_RCRD,  |
| m_ROLB,   | m_ROLW,   | m_ROLD,  |
| m_RORB,   | m_RORW,   | m_RORD,  |
| m_SALB,   | m_SALW,   | m_SALD,  |
| m_SARB,   | m_SARW,   | m_SARD,  |
| m_SHLB,   | m_SHLW,   | m_SHLDW, |
| m_SHRB,   | m_SHRW,   | m_SHRDW, |
| m_SBBB,   | m_SBBW,   | m_SBBD,  |
| m_SCASB,  | m_SCASW,  | m_SCASD, |
| m_STOSB,  | m_STOSW,  | m_STOSD, |
| m_SUBB,   | m_SUBW,   | m_SUBD,  |
| m_TESTB,  | m_TESTW,  | m_TESTD, |
| m_XORB,   | m_XORW,   | m_XORD,  |
| m_DATAB,  | m_DATAW,  | m_DATAD  |

-- Special 'instructions'

m\_label, m\_reset);



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```
type operand_type is ( none,                -- no operands

    immediate,                             -- 1 immediate operand
    register,                              -- 1 register operand
    address,                               -- 1 address operand
    system_address,                        -- 1 'address operand
    name,                                  -- CALL name
    register_immediate,                   -- 2 operands: dest is
                                           -- register, source is
                                           -- immediate
    register_register,                    -- 2 register operands
    register_address,                     -- 2 operands: dest is register,
                                           -- source is address
    address_register,                     -- 2 operands: dest is address,
                                           -- source is register
    register_system_address,              -- 2 operands: dest is register,
                                           -- source is 'address
    system_address_register,              -- 2 operands: dest is 'address,
                                           -- source is register
    address_immediate,                    -- 2 operands: dest is 'address,
                                           -- source is immediate
    system_address_immediate,              -- 2 operands: dest is 'address,
                                           -- source is immediate
    immediate_register,                   -- only allowed for OUT port is
                                           -- immediate source is register
    immediate_immediate,                  -- only allowed for ENTER
    register_register_immediate,           -- allowed for IMULImm,SHRDimm,
                                           -- and SHLDimm
    register_address_immediate             -- allowed for IMULImm
    register_system_address_immediate      -- allowed for IMULImm
    address_register_immediate             -- allowed for SHRDimm,
                                           -- SHLDimm
    system_address_register_immediate      -- allowed for SHRDimm,
                                           -- SHLDimm
);

type register_type is ( AX, CX, DX, BX,    -- word registers
    SP, BP, SI, DI,                        --
    AL, CL, DL, BL,                       -- byte registers
    AH, CH, DH, BH,                       --
    EAX, ECX, EDX, EBX                    -- dword registers
    ESP, EBP, ESI, EDI                    --
    ES, CS, SS, DS,                       -- selector registers
    FS, GS                                --
    BX_SI, BX_DI,                         -- 8086/80186/80286
    BP_SI, BP_DI,                         -- combinations
    ST, ST1, ST2, ST3,                   -- floating stack registers
    ST4, ST5, ST6, ST7,
    nil );
```



```
type segment_register is ( ES, CS, SS, DS, FS, GS, nil );

subtype machine_string is string (1..100);

pragma page;
type machine_instruction (operand_kind : operand_type is record
    opcode          : opcode_type;

    case operand_kind is
        when immediate =>
            immediate      : integer;

        when register =>
            r_register      : register_type;

        when address =>
            a_segment       : register_type;
            a_address_reg   : register_type;
            a_offset        : integer;

        when system_address =>
            sa_address      : system.address;

        when name =>
            n_string        : machine_string;

        when register_immediate =>
            r_i_register    : register_type;
            r_i_immediate   : integer;

        when register_register =>
            r_r_register_to : register_type;
            r_r_register_from : register_type;

        when register_address =>
            r_a_register_to : register_type;
            r_a_segment     : segment_register;
            r_a_address_reg : register_type;
            r_a_offset      : integer;

        when address_register =>
            a_r_segment     : segment_register;
            a_r_address_reg : register_type;
            a_r_offset      : integer;
            a_r_register_from : register_type;

        when register_system_address =>
            r_sa_register_to : register_type;
            r_sa_address     : system.address;

        when system_address_register =>
            sa_r_address     : system.address;
            sa_r_reg_from    : register_type;
```





```
when address_immediate =>
  a_i_segment      : segment_register;
  a_i_address_reg   : register_type;
  a_i_offset        : integer;
  a_i_immediate     : integer;

when system_address_immediate =>
  sa_i_address      : system.address;
  sa_i_immediate     : integer;

when immediate_register =>
  i_r_register      : integer;
  i_r_register      : register_type;

when immediate_immediate =>
  i_i_immediate1    : integer;
  i_i_immediate2    : integer;

when register_register_immediate =>
  r_r_i_register1   : register_type;
  r_r_i_register2   : register_type;
  r_r_i_immediate2   : integer;

when register_address_immediate =>
  r_a_i_register    : register_type;
  r_a_i_segment      : register_type;
  r_a_i_address_reg  : register_type;
  r_a_i_offset       : integer;
  r_a_i_immediate    : integer;

when register_system_address_immediate =>
  r_sa_i_register    : register_type;
  addr10             : system.address;
  r_sa_i_immediate    : integer;

when address_register_immediate =>
  a_r_i_register     : register_type;
  a_r_i_segment      : register_type;
  a_r_i_address_reg   : register_type;
  a_r_i_offset        : integer;
  a_r_i_immediate     : integer;

when system_address_register_immediate =>
  sa_r_i_address      : system.address;
  sa_r_i_register      : register_type;
  sa_r_i_immediate     : integer;

when others =>
  null;
end case;
end record;
```



### F.9.2 Restrictions

Only procedures, and not functions, may contain machine code insertions. Also procedures that use machine code insertions specified with PRAGMA inline.

Symbolic names in the form x'ADDRESS can only be used in the following cases:

- 1) x is an object of scalar type or access type declared as an object, a formal parameter, or by static renaming.
- 2) x is an array with static constraints declared as an object (not as a formal parameter or by renaming).
- 3) x is a record declared as an object (not a formal parameter or by renaming).

All opcodes defined by the type OPCODE\_type except the m\_CALL can be used.

Two opcodes to handle labels have been defined:

m\_label: defines a label. The label number must be in the range  $1 \leq x \leq 25$  and is put in the offset field in the first operand of the MACHINE\_INSTRUCTION.

m\_reset: used to enable use of more than 25 labels. The label number after a m\_RESET must be in the range  $1 \leq x \leq 25$ . To avoid errors you must make sure that all used labels have been defined before a reset, since the reset operation clears all used labels.

All floating instructions have at most one operand which can be any of the following:

- a memory address
- a register or an immediate value
- an entry in the floating stack

### F.9.3 Examples

The following section contains examples of how to use the machine code insertions and lists the generated code.



### F.9.3.2 Example Using Labels

The following assembler code can be described by machine code insertions as shown:

```
MOV     AX,7
MOV     CX,4
CMP     AX,CX
JG      1
JE      2
MOV     CX,AX
1: ADD   AX,CX
2: MOV   SS:[BP+DI], AX
```

with MACHINE\_CODE; use MACHINE\_CODE;  
package example\_MC is

```
    procedure test_labels;
    pragma inline (test_labels);
```

end example\_MC;

package body example\_MC is

procedure test\_labels is

begin

```
        MACHINE_INSTRUCTION'(register_immediate, m_MOV, AX, 7);
        MACHINE_INSTRUCTION'(register_immediate, m_MOV, CX, 4);
        MACHINE_INSTRUCTION'(register_register, m_CMP, AX, CX);
        MACHINE_INSTRUCTION'(immediate, m_JG, 1);
        MACHINE_INSTRUCTION'(immediate, m_JE, 2);
        MACHINE_INSTRUCTION'(register_register, m_MOV, CX, AX);
        MACHINE_INSTRUCTION'(immediate, m_label, 1);
        MACHINE_INSTRUCTION'(register_register, m_ADD, AX, CX);
        MACHINE_INSTRUCTION'(immediate, m_label, 2);
        MACHINE_INSTRUCTION'(address_register, m_MOV, SS, BP_DI, 0, AX);
```

end test\_labels;

end example\_MC;



## F.10 Package Tasktypes

The TaskTypes packages defines the TaskControlBlock type. This data structure could be useful in debugging a tasking program.

with System;  
package TaskTypes is

```
subtype Offset      is System.UnsignedDWord;
subtype BlockId     is System.UnsignedDWord;

type TaskEntry      is new System.UnsignedDWord;
type EntryIndex     is new System.UnsignedDWord;
type AlternativeId  is new System.UnsignedDWord;
type Ticks          is new System.UnsignedDWord;
type Bool           is new Boolean;
for Bool'size       use 8;
type UIntg          is new System.UnsignedDWord;

type TaskState      is (Initial,
                        Engaged,
                        Running,
                        Delayed,
                        EntryCallingTimed,
                        EntryCallingUnconditional,
                        SelectingTimed,
                        SelectingTerminable,
                        Accepting,
                        Synchronizing,
                        Completed,
                        Terminated);
```

```
type TaskTypeDescriptor is
record
  priority           : System.Priority;
  entry_count        : UIntg;
  block_id           : BlockId;
  first_own_address  : System.Address;
  module_number      : UIntg;
  entry_number       : UIntg;
  code_address       : System.Address;
  stack_size         : System.QWord;
  stack_segment_size : UIntg;
end record;
```

type NPXSaveArea is array(1..48) of System.Word;

```
pragma page;
type TaskControlBlock is
record
  sem                : System.Semaphore;
```



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### -- Delay queue handling

dnext : System.TaskValue ;  
dprev : System.TaskValue ;  
ddelay : Ticks ;

### -- Saved registers

SS : System.Word ;  
SP : Offset ;

### -- Ready queue handling

next : System.TaskValue ;

### -- Semaphore handling

semnext : System.TaskValue ;

### -- Priority fields

priority : System.Priority;  
saved\_priority : System.Priority;

time\_slice : Ticks;

stack\_start : Offset;  
stack\_end : Offset;

### -- State fields

state : TaskState;  
is\_abnormal : Bool;  
is\_activated : Bool;  
failure : Bool;

### -- Activation handling fields

activator : System.TaskValue;  
act\_chain : System.TaskValue;  
next\_chain : System.TaskValue;  
no\_not\_act : System.Word;  
act\_block : BlockId;

### -- Accept queue fields

partner : System.TaskValue;  
next\_partner : System.TaskValue;

### -- Entry queue fields

next\_caller : System.TaskValue;



-- Rendezvous fields

called\_task : System.TaskValue;  
task\_entry : TaskEntry;  
entry\_index : EntryIndex;  
entry\_assoc : System.Address;  
call\_params : System.Address;  
alt\_id : AlternativeId;  
excp\_id : System.ExceptionId;

-- Dependency fields

parent\_task : System.TaskValue;  
parent\_block : BlockId;  
child\_task : System.TaskValue;  
next\_child : System.TaskValue;  
first\_child : System.TaskValue;  
prev\_child : System.TaskValue;  
child\_act : System.Word;  
block\_act : System.Word;  
terminated\_task : System.TaskValue;

-- Abortion handling fields

busy : System.Word;

-- Auxiliary fields

ttd : TaskTypeDescriptor;  
segment\_size : System.Word;

-- Run-Time System fields

ACF : Offset;  
collection : System.Address;

-- NPX save area

NPXSave : NPXSaveArea;  
end record;

end TaskTypes;

APPENDIX C  
TEST PARAMETERS

Certain tests in the ACVC make use of implementation-dependent values, such as the maximum length of an input line and invalid file names. A test that makes use of such values is identified by the extension .TST in its file name. Actual values to be substituted are represented by names that begin with a dollar sign. A value must be substituted for each of these names before the test is run. The values used for this validation are given below.

| Name and Meaning   | Value                 |
|--|-----------------------|
| \$BIG_ID1<br>Identifier the size of the<br>maximum input line length with<br>varying last character.                                     | <125 X "A">1          |
| \$BIG_ID2<br>Identifier the size of the<br>maximum input line length with<br>varying last character.                                     | <125 X "A">2          |
| \$BIG_ID3<br>Identifier the size of the<br>maximum input line length with<br>varying middle character.                                   | <63 X "A">3<62 X "A"> |
| \$BIG_ID4<br>Identifier the size of the<br>maximum input line length with<br>varying middle character.                                   | <63 X "A">4<62 X "A"> |
| \$BIG_INT_LIT<br>An integer literal of value 298<br>with enough leading zeroes so<br>that it is the size of the<br>maximum line length.  | <123 X "0">298        |
| \$BIG_REAL_LIT<br>A universal real literal of<br>value 690.0 with enough leading<br>zeroes to be the size of the<br>maximum line length. | <120 X "0">69.0E1     |

|  |                     |
|--|---------------------|
| \$BIG_STRING1  | <63 X "A">          |
| A string literal which when catenated with BIG_STRING2 yields the image of BIG_ID1.                                    |                     |
| \$BIG_STRING2  | <62 X "A">1         |
| A string literal which when catenated to the end of BIG_STRING1 yields the image of BIG_ID1.                           |                     |
| \$BLANKS   | <106 X " ">         |
| A sequence of blanks twenty characters less than the size of the maximum line length.                                  |                     |
| \$COUNT_LAST   | 2147483647          |
| A universal integer literal whose value is TEXT_IO.COUNT'LAST.   |                     |
| \$FIELD_LAST   | 35                  |
| A universal integer literal whose value is TEXT_IO.FIELD'LAST.   |                     |
| \$FILE_NAME_WITH_BAD_CHARS   | "abc^&.!@#longname" |
| An external file name that either contains invalid characters or is too long.  |                     |
| \$FILE_NAME_WITH_WILD_CARD_CHAR  | "abv%.*longname2"   |
| An external file name that either contains a wild card character or is too long.                                       |                     |
| \$GREATER_THAN_DURATION  | 100_000.0           |
| A universal real literal that lies between DURATION'BASE'LAST and DURATION'LAST or any value in the range of DURATION. |                     |
| \$GREATER_THAN_DURATION_BASE_LAST  | 200_000.0           |
| A universal real literal that is greater than DURATION'BASE'LAST.  |                     |
| \$ILLEGAL_EXTERNAL_FILE_NAME1  | "BAD-CHARACTER*^"   |
| An external file name which contains invalid characters.   |                     |



|  |                     |
|--|---------------------|
| \$ILLEGAL_EXTERNAL_FILE_NAME2  | "BAD-CHARACTER*^"   |
| An external file name which is too long.   |                     |
| \$INTEGER_FIRST  | -2147483648         |
| A universal integer literal whose value is INTEGER'FIRST.  |                     |
| \$INTEGER_LAST   | 2147483647          |
| A universal integer literal whose value is INTEGER'LAST.   |                     |
| \$INTEGER_LAST_PLUS_1  | 2147483648          |
| A universal integer literal whose value is INTEGER'LAST + 1.   |                     |
| \$LESS_THAN_DURATION   | -100_000.0          |
| A universal real literal that lies between DURATION'BASE'FIRST and DURATION'FIRST or any value in the range of DURATION. |                     |
| \$LESS_THAN_DURATION_BASE_FIRST  | -200_000.0          |
| A universal real literal that is less than DURATION'BASE'FIRST.  |                     |
| \$MAX_DIGITS   | 15                  |
| Maximum digits supported for floating-point types.   |                     |
| \$MAX_IN_LEN   | 126                 |
| Maximum input line length permitted by the implementation.   |                     |
| \$MAX_INT  | 9223372036854775807 |
| A universal integer literal whose value is SYSTEM.MAX_INT.   |                     |
| \$MAX_INT_PLUS_1   | 9223372036854775808 |
| A universal integer literal whose value is SYSTEM.MAX_INT+1.   |                     |
| \$MAX_LEN_INT_BASED_LITERAL  | <121 X "0"> 2:11:   |
| A universal integer based literal whose value is 2#11# with enough leading zeroes in the mantissa to be MAX_IN_LEN long. |                     |

|   |  |
|---|--|
| <p><b>\$MAX_LEN_REAL_BASED_LITERAL</b><br/> A universal real based literal whose value is 16:F.E: with enough leading zeroes in the mantissa to be MAX_IN_LEN long.</p> | <p>16:&lt;119 X "0"&gt;F.E</p>             |
| <p><b>\$MAX_STRING_LITERAL</b><br/> A string literal of size MAX_IN_LEN, including the quote characters.</p>  | <p>"&lt;12 X "1234567890" + "1234"&gt;</p> |
| <p><b>\$MIN_INT</b><br/> A universal integer literal whose value is SYSTEM.MIN_INT.</p>   | <p>-9223372036854775808</p>                |
| <p><b>\$NAME</b><br/> A name of a predefined numeric type other than FLOAT, INTEGER, SHORT_FLOAT, SHORT_INTEGER, LONG_FLOAT, or LONG_INTEGER.</p>                       | <p>SHORT_SHORT_INTEGER</p>                 |
| <p><b>\$NEG_BASED_INT</b><br/> A based integer literal whose highest order nonzero bit falls in the sign bit position of the representation for SYSTEM.MAX_INT.</p>     | <p>16#ffffffff#</p>                        |

## APPENDIX D

### WITHDRAWN TESTS

Some tests are withdrawn from the ACVC because they do not conform to the Ada Standard. The following 28 tests had been withdrawn at the time of validation testing for the reasons indicated. A reference of the form "AI-ddddd" is to an Ada Commentary.

- B28003A: A basic declaration (line 36) wrongly follows a later declaration.
- E28005C: This test requires that 'PRAGMA LIST (ON);' not appear in a listing that has been suspended by a previous "pragma LIST (OFF);"; the Ada Standard is not clear on this point, and the matter will be reviewed by the ARG.
- C34004A: The expression in line 168 wrongly yields a value outside of the range of the target type T, raising CONSTRAINT\_ERROR.
- C35502P: Equality operators in lines 62 & 69 should be inequality operators.
- A35902C: Line 17's assignment of the nominal upper bound of a fixed-point type to an object of that type raises CONSTRAINT\_ERROR, for that value lies outside of the actual range of the type.
- C35904A: The elaboration of the fixed-point subtype on line 28 wrongly raises CONSTRAINT\_ERROR, because its upper bound exceeds that of the type.
- C35904B: The subtype declaration that is expected to raise CONSTRAINT\_ERROR when its compatibility is checked against that of various types passed as actual generic parameters, may in fact raise NUMERIC\_ERROR or CONSTRAINT\_ERROR for reasons not anticipated by the test.
- C35A03E, These tests assume that attribute 'MANTISSA returns 0 when  
& R: applied to a fixed-point type with a null range, but the Ada Standard doesn't support this assumption.
- C37213H: The subtype declaration of SCONS in line 100 is wrongly expected to raise an exception when elaborated.
- C37213J: The aggregate in line 451 wrongly raises CONSTRAINT\_ERROR.

C37215C: Various discriminant constraints are wrongly expected  
E, G, H: to be incompatible with type CONS.

C38102C: The fixed-point conversion on line 23 wrongly raises  
CONSTRAINT\_ERROR.

C41402A: 'STORAGE\_SIZE is wrongly applied to an object of an access  
type.

C45332A: The test expects that either an expression in line 52 will  
raise an exception or else MACHINE\_OVERFLOW is FALSE.  
However, an implementation may evaluate the expression  
correctly using a type with a wider range than the base type of  
the operands, and MACHINE\_OVERFLOW may still be TRUE.

C45614C: REPORT.IDENT\_INT has an argument of the wrong type  
(LONG\_INTEGER).

E66001D: AI-330 states this test is to be changed from an "E" test to a  
"B" test during the next version of the ACVC. AI-330 was  
approved in July 1986, 6 months before the initial version of  
ACVC Version 1.9 was released and a nearly a full year before  
the final version of ACVC Version 1.9 was released. This test  
is withdrawn pending further comment from AJPO regarding issue  
of the test being a B Test rather than an E Test.

A74106C: A bound specified in a fixed-point subtype declaration  
C85018B, lies outside of that calculated for the base type, raising  
C87B04B, CONSTRAINT\_ERROR. Errors of this sort occur re lines 37 & 59,  
CC1311B: 142 & 143, 16 & 48, and 252 & 253 of the four tests,  
respectively (and possibly elsewhere).

BC3105A: Lines 159..168 are wrongly expected to be illegal; they are  
legal.

AD1A01A: The declaration of subtype INT3 raises CONSTRAINT\_ERROR for  
implementations that select INT'SIZE to be 16 or greater.

CE2401H: The record aggregates in lines 105 & 117 contain the wrong  
values.

CE3208A: This test expects that an attempt to open the default output  
file (after it was closed) with mode IN\_FILE raises NAME\_ERROR  
or USE\_ERROR; by Commentary AI-00048, MODE\_ERROR should be  
raised.